U S DEPARTMENT OF PATENT AND TRADEMARK OFFICE

ATTORNEY'S DOCKET NUMBER R 37032

JC07 Rec'd PCT/PTO 22 MAR 2002

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

U.S. APPLICATION NO (if known)

10/088867

INTERNATIONAL APPLICATION NO	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/DE 00/03024	September 2, 2000	September 30, 1999

TITLE OF THE INVENTION

Combustion Misfire Detection

APPLLICANT(S) FOR DO/EO/US

Michael Lehner and Andrea Lohmann

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is the **FIRST** submission of items concerning a filing under 35 U.S C 371.
2. ☐ This is the **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U S C. 371.
3. ☐ This express request to begin national examination procedures (35 U S C. 371(f) at any time rather than delay examination until the expiration of the applicable time limit set in 35 U S C 371(b) and PCT Articles 22 and 39(1)
4. ☒ A proper Demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date

5. ☒ A copy of the International Application as filed (35 U.S C. 371(c)(2))
   a. ☒ is transmitted herewith (required only if not transmitted by the International Bureau).
   b. ☐ has been transmitted by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office (RO/US).
6. ☒ A translation of the International Application into English (35 U.S.C 371(c)(2))

7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C 371(c)(3))
   a. ☐ are transmitted herewith (required only if not transmitted by the International Bureau)
   b. ☐ have been transmitted by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.

8. ☐ A translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

9. ☐ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4))

10. ☐ A translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11. to 16. below concern other document(s) or information included:

11. ☒ An Information Disclosure Statement under 37 CFR 1 97 and 1 98.

12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3 31 is included.

13. ☒ A FIRST preliminary amendment.
    ☐ A SECOND or SUBSEQUENT preliminary amendment.

14. ☐ A substitute specification.

15. ☐ A change of power of attorney and/or address letter

16. ☒ Other items or information:

    1. Four (4) sheet(s) of drawing
    2. Form PCT/RO/101
    3. Form PCT/ISA/210
    4. Form PCT/ISA/220
    5. Form PCT/IPEA/409
    6. Form PCT/IPEA/416

U.S. APPLICATION NO (if known)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
10/088867	PCT/DE 00/03024	R 37032

17. [X] The following fees are submitted.	CALCULATIONS	PTO USE ONLY
Basic National Fee (37 CFR 1.492(a)(1)-(5)):		
Search Report has been prepared by the EPO or JPO..... $890 00	$890.00	
International preliminary examination fee paid to USPTO (37 CFR 1 482) $710 00		
No international preliminary examination fee paid to USPTO (37 CFR 1 482) but international search fee paid to USPTO (37 CFR 1.445(a)(2))..... $740.00		
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1 445(a)(2) paid to USPTO..... $1,040.00		
International preliminary examination fee paid to USPTO (37 CFR 1 482) and all claims satisfied provisions of PCT Article 33(2)-(4) $100.00		
ENTER APPROPRIATE BASIC FEE AMOUNT =	$890.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1 492(e)).		

Claims	Number Filed	Number Extra	Rate		
Total Claims	3 - 20 =	0	X $18 00		
Independent Claims	2 - 3 =	0	X $84.00		
Multiple dependent claim(s) (if applicable)			+ $280		
TOTAL OF ABOVE CALCULATIONS =				$890.00	
Reduction by 1/2 for filing by small entity, if applicable Verified Small Entity Statement must also be filed. (Note 37 CFR 1.9, 1.27, 1.28)					
SUBTOTAL =				$890.00	
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f))					
TOTAL NATIONAL FEE =				$890.00	
Fee for recording the enclosed assignment (37 CFR 1.21(h)) The assignment must be accompanied by an appropriate cover sheet (37 CFR 3 28, 3.31). **$40.00** per property +					
TOTAL FEES ENCLOSED =				$890.00	
				Amount to be refunded	
				charged	

a. [Y] A check in the amount of $890 00 to cover the above fee is enclosed

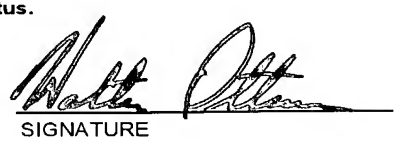
b. [ ] Please charge my Deposit Account No. 15-0773 in the amount of $860.00 to cover the above fees. A duplicate copy of this sheet is enclosed

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 15-0773 A duplicate copy of this sheet is enclosed.

Note: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO.

Walter Ottesen
Patent Attorney
P.O. Box 4026
Gaithersburg, Maryland 20885-4026



SIGNATURE

Walter Ottesen
NAME

25,544
REGISTRATION NUMBER

In the United States Patent and Trademark Office

In re patent application of: Michael Lehner
and Andrea Lohmann

International Application No: PCT/DE 00/03024 filed on September 2, 2000

Priority Claimed: German patent application 199 46 873.7 filed on September 30, 1999

Title of Invention: Combustion Misfire Detection

Attorney Docket: R 37032

Preliminary Amendment

Honorable Commissioner of
Patent and Trademarks
Washington, D. C. 20231

Dear Sir:

Please amend the above-identified application as delineated below.

In the Disclosure:

On page 1, please delete line 3 and substitute therefor the following:

-- Field of the Invention --.

On page 1, between lines 6 and 7, please insert the following:

-- Background of the Invention --.

On page 1, please delete line 21 and substitute therefor the following:

-- from United States Patent 5,955,663. --.

On page 2, between lines 13 and 14, please insert the following:

-- Summary of the Invention --.

On page 2, please delete lines 16 and 17.

On page 3, please delete line 2.

On page 3, please delete line 15 and substitute the following therefor:

-- Brief Description of the Drawing --.

On page 4, between lines 2 and 3, please insert the following:

-- Description of the Preferred Embodiments of the Invention --.

In the Abstract:

On page 9, please delete lines 1 and 2 and substitute therefor:

-- Abstract of the Disclosure --.

In the Claims:

Please cancel claims 1 to 4 and add claims 5 to 7 as follows:

5. A method for detecting combustion misfires in an internal combustion engine, the method comprising the steps of:

considering the position of angular segments relative to a reference point (TDC) of the movement of the piston of the engine which are dependent upon at least one operating parameter of the engine; and,

evaluating segment times in which a shaft of the engine passes through said angle segments.

6. The method of claim 5, comprising the further step of considering an angle expansion of the angle segments; and, causing the angle expansion of the angle segments to be dependent upon at least an operating parameter of the engine.

7. A method for detecting combustion misfires in an internal combustion engine, the method comprising the steps of:

determining whether engine rpm (n) and engine load (L) lie in a segment length (L1);

if yes, then forming segment time (ts) having a first segment length (1) and, if no, then forming segment time (ts) having a second segment length (2);

determining whether engine rpm (n) and engine load (L) lie in a segment start (1);

if yes, then forming a segment time (ts) having a segment start (1) and, if no, then forming a segment time (ts) having a segment start (2);

determining if segment time (ts) is greater than a threshold; and,

if yes, then switching on a fault lamp indicating the presence of a misfire.

Remarks

Claims 5 to 7 have been added and claims 1 to 4 are cancelled so that claims 5 to 7 are pending in this application of which claims 5 and 7 are in independent form. The new claims make improvements as to the form of the original claims.

The disclosure has been amended to add appropriate headings.

Respectfully submitted,

Walter Ottesen
Reg. No. 25,544

Walter Ottesen
Patent Attorney
P.O. Box 4026
Gaithersburg, Maryland 20885-4026

Phone: (301) 869-8950

Date: March 22, 2002

In the United States Patent and Trademark Office

In re patent application of: Michael Lehner and Andrea Lohmann

International Application No: PCT/DE 00/03024 filed on September 2, 2000

Priority Claimed: German patent application 199 46 873.7 filed on September 30, 1999

Title of Invention: Combustion Misfire Detection

Attorney Docket: R 37032

Verification of Translation of

International Patent Application PCT/DE 00/03024

Honorable Commissioner of
Patent and Trademarks
Washington, D. C. 20231

Dear Sir:

I, the below named translator, hereby declare that: my name and post office address are as stated below; that I am knowledgeable in the English language and in the German language of the International Patent Application PCT/DE 00/03024 and I believe the attached English translation to be a true and complete translation of this document.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine of imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of the translator: Karen Ottesen
Date: 3/22/02
Signature of the translator: Karen Ottesen
Post Office Address: P.O. Box 4026
Gaithersburg, Maryland 20885-4026

Combustion Misfire Detection

State of the Art

The invention relates to a method for detecting combustion misfires in internal combustion engines as they are used for the drive of motor vehicles.

Combustion misfires lead to an increase of the toxic substances, which are emitted during the operation of the internal combustion engine, and can lead to damage of a catalytic converter in the exhaust-gas system of the engine. To satisfy statutory requirements for on-board monitoring of exhaust-gas relevant functions, a detection of combustion misfires is necessary in the entire rpm and load ranges. In this connection, it is known that characteristic changes of the rpm characteristic trace or curve of the internal combustion engine occur during operation with combustion misfires compared to the normal operation without misfires. One can distinguish between normal operation without misfires and operation with misfires from the comparison of these rpm traces.

A method, which operates on this basis, is already known from DE-OS 196 27 540.

In this known method, a crankshaft angle region, which is identified as a segment, is assigned to a specific region of the piston movement of each cylinder. The segments are realized, for example, by markings on a transducer wheel coupled to the crankshaft. The segment time is the time in which the crankshaft passes through this angular region and is dependent, inter alia, on the energy converted in the combustion stroke. Misfires lead to an increase of the ignition-synchronously detected segment times. According to the known method, an index for the rough

running of the engine is computed from the differences of segment times. Additionally, slow dynamic operations, for example, the increase of the engine rpm during a vehicle acceleration are compensated by computation. A rough-running value, which is computed in this way for each ignition, is likewise compared ignition-synchronously to a predetermined threshold value. This threshold value is dependent, if required, on operating parameters such as load and rpm and exceeding this threshold value is evaluated as a misfire.

The reliability of the method is decisively dependent upon the accuracy with which the rpm differences of the crankshaft, which are characteristic for misfires, can be determined from the segment times.

In view of this background, it is an object of the invention to further increase this accuracy.

This object is solved with the combination of features of claim 1.

A significant element of the solution comprises that

- the position of the angle segments relative to a reference point of the movement of the pistons of the engine and/or
- the angular expansion of the angle segments is dependent upon operating parameters of the engine.

The invention is based on the realization that the determination of a single segment position and segment length for the entire engine operating range, as known up to now, is not optimal. According to the invention, the position and/or the length of the segments is dependent upon the operating parameters of the engine. Suitable operating parameters on which the start and length of the segments can depend are, for example, the torque, the load, or the cylinder charge and the rpm of the

engine.

Advantages of the Invention

The disturbance distance, that is, the distance between the rough-running signal, which is disturbed by misfires, to the undisturbed rough-running signal is increased by the more ideal position and length of the segment times.

In this way, the recognition quality improves. The increase of the sensitivity associated therewith permits also the detection of smaller differences in the combustions, for example, from unwantedly different injection quantities which can be caused by the formation of combustion residues on the injection valves.

From the above, interventions into the injection for the compensation of different injection quantities are realized on the basis of the rough running.

Drawing

The embodiments of the invention are described in the following with reference to the drawings.

FIG. 1 shows the technical background of the invention.

FIG. 2 shows details of the rpm sensors and the time-dependent trace of the signal of the rpm sensor 4 on the crankshaft of the engine plus the phase signal of the sensor 6 on the camshaft.

FIG. 3 shows the known principle of forming segment times as the basis of an index for the rough running on the basis of rpm measurements.

FIG. 4 shows a possible assignment of different segment lengths and segment positions to different operating ranges of the engine.

FIG. 5 discloses a flow diagram as an embodiment of the method according to the invention.

FIG. 1 shows an internal combustion engine 1 having an angle transducer wheel 2 which carries markings 3 as well as an angle sensor 4, a control apparatus 5, a phase sensor 6, means 7 for detecting the air quantity which flows into the engine and a fault lamp 8.

FIG. 2a shows details of the rpm transducer system comprising angle transducer wheel 2 and angle sensor 4. The angle transducer wheel is, for example, mounted on the crankshaft as a ferromagnetic transducer wheel having space for 60 teeth. Two teeth (tooth gap) are omitted. The inductive rpm sensor scans this tooth sequence of 58 teeth. The rpm sensor comprises a permanent magnet 4.1 and a soft iron core 4.2 having a copper winding. The magnetic flux changes in the sensor when the transducer wheel teeth pass the sensor. An alternating voltage is induced as shown in FIG. 2b.

The control apparatus detects the tooth gap from the enlarged spacing of the signal flanks. The tooth gap is assigned to a defined crankshaft position which has a fixed reference to top dead center TDC of the first cylinder. The signal of the phase sensor 6 is shown in FIG. 2c and permits one to distinguish between charge change TDC and ignition TDC. For this purpose, the sensor 6 supplies information in the form of a marking in the signal as to the angular position of the crankshaft relative to the camshaft. Since the crankshaft rotates at twice the camshaft frequency in a four-stroke engine, the information is sufficient as to whether the actual camshaft position is assigned to the first or to the second crankshaft rotation.

If the marking of the signal of the phase sensor is coincident with the gap in the signal of the rpm sensor, then the control apparatus detects the ignition TDC of the first cylinder. With each successive positive or negative flank, the control apparatus counts the crankshaft position, for example, another 6° farther.

The control apparatus can detect the ignition TDC of the remaining cylinders from the total number of the teeth and the cylinder number. With four cylinders and a 60-2 transducer wheel, the ignition TDCs follow one another at a spacing of 28 or 30 teeth. For forming segment times, fifteen teeth ahead of ignition TDC, a time measurement for an angle segment is started which extends, for example, over 30 teeth. The selection of the start and length makes possible any desired lengths and positions of the segment between which a switchover can be made in dependence upon operating parameters.

The time durations ts in which the crankshaft passes over the segments so defined are further processed in the control apparatus 5 to an index Lut for the rough running of the engine. The control apparatus 5 is realized as a computer.

In FIG. 3, the times ts are plotted at which the angular regions is passed through because of the rotational movement of the crankshaft. Here, a misfire in a cylinder is assumed. The lack of torque associated with the misfire leads to an increase of the corresponding time span ts. The time spans ts thereby define already an index Lut for the rough running which is, in principle, suitable for detecting misfires.

Typically, one or two segments times per ignition are formed. In the formation of one segment time per ignition and

the utilization of all markings of the transducer wheel, a segment length of 720° divided by the number of cylinders results. This leads to a segment of 180° length in a four-cylinder engine and this segment can, for example, be arranged symmetrically with respect to the ignition TDC. Up to now, fixed lengths and arrangements were used which, for example, were optimized for the detection-critical regions of low load and high rpm. At low rpms, for example, a different segment position of 126° crankshaft angle ahead of TDC up to 54° crankshaft angle after TDC would be more suitable.

An overlapping of sequential segments is likewise possible, for example, with a segment length >180° KW in a four-cylinder engine.

According to the invention, a switchover between several segments lengths and segment positions is dependent upon operating points. For example, at high rpms, the segment time for a four-cylinder engine is formed from 180° KW ahead of TDC up to 72° KW after TDC (segment start 1 in FIG. 4b) and, at low rpms, from 126° KW ahead of TDC to 54° KW after TDC (segment start 2 in FIG. 4b).

One can also imagine, however, a switchover across three or more regions.

Likewise, the length of the segments can be varied in dependence upon operating points so that, for example, at high rpms, segments of 180° KW (segment length 1 in FIG. 4a) and, at low rpms, segments of 162° KW length (segment length 2 in FIG. 4a) can be formed.

The switchover between different positions and between different lengths can also be combined.

For a switchover, a hysteresis can be provided in lieu of fixed limits.

This is shown as an example in FIG. 4c. There, for a transition from low load to high load, the region switchover from region L1 and/or B1 to region L2 and/or B2 is undertaken at another load value than for the transition from the opposite direction.

FIG. 5 shows a flowchart as an embodiment of the method of the invention which is cyclically called up (step "start") by a higher ranking engine control program. In step 5.1, a check is made as to whether the rpm n and the load L lie in a region L1. If this answered in the affirmative then, in step 5.2, the segment time formation with the segment length 1 (see FIG. 4a) follows. Otherwise, in step 5.3, the segment time formation takes place with the segment length 2.

Thereafter, the selection of the segment start follows in steps 5.4 to 5.6. With the segment times, which are determined on the basis of the selected segment lengths and segment positions, a detection of combustion misfires takes place. In the embodiment shown, step 5.7 serves for this purpose. If the segment times exceed a predetermined threshold value, then, in step 5.8, the fault lamp is switched on. Before switching on the fault lamp an assurance of the fault announcement can be provided by evaluating the frequency of occurrence of the threshold value being exceeded (misfires) in relationship to the number of regular combustions or to the number of work strokes (combustions plus misfires).

Claims

1. Method for detecting combustion misfires in internal combustion engines on the basis of an evaluation of segment times wherein a shaft of the engine passes over predetermined angular segments, characterized in that:

the position of the angular segments relative to a reference point of the movement of the pistons of the engine and/or

the angular expansion of the angle segments is dependent upon at least one operating parameter of the engine.

2. Method of claim 1, characterized by a dependency upon load and/or rpm of the engine.

3. Method of claim 1 or 2, characterized by a dependency upon rpm of the engine.

4. Method of claim 2 or 3, characterized in that the dependency upon position and/or the length of the angle segment is dependent additionally upon the direction of the change of at least one operating parameter (hysteresis).

Internal Combustion Misfire Detection Method

Summary

A method for detecting combustion misfires in internal combustion engines on the basis of an evaluation of the segment times is introduced wherein a shaft of the engine passes over predetermined angular segments. The method is characterized by variable segment lengths and/or segment positions relative to a reference point of the movement of the pistons of the engine. The position of the angle segments and/or the segment length, that is, the angular expansion of the angular segments, is dependent upon operating parameters of the engine.

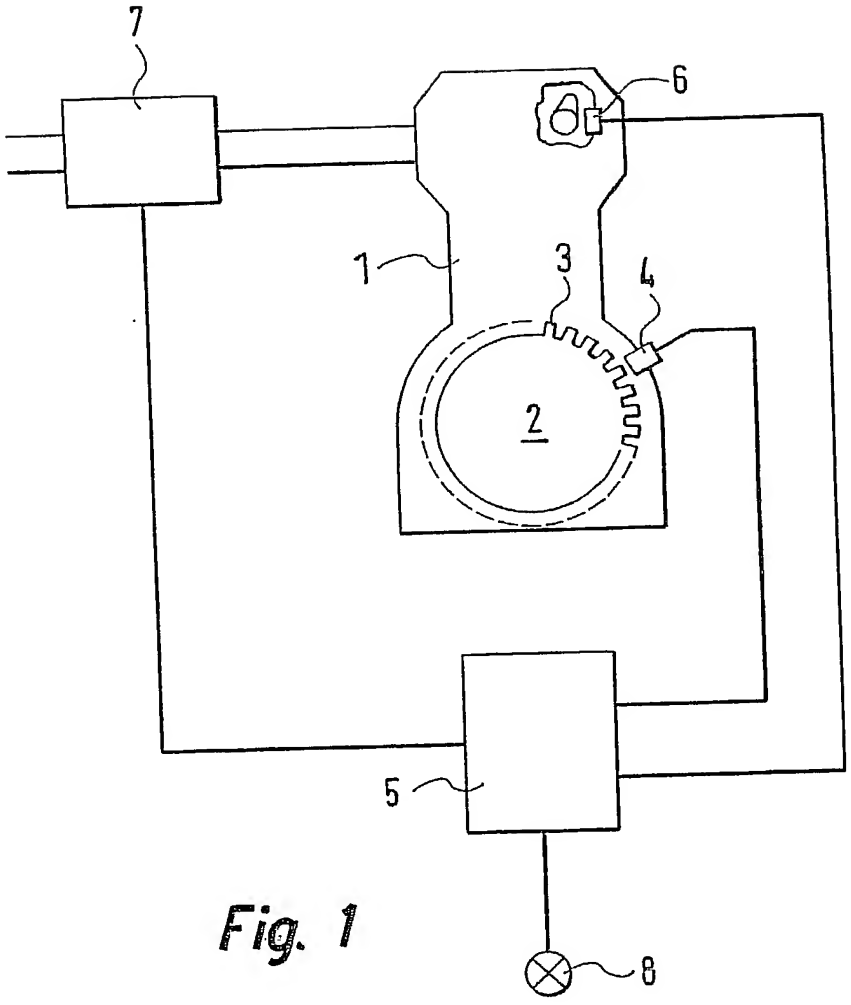


Fig. 1

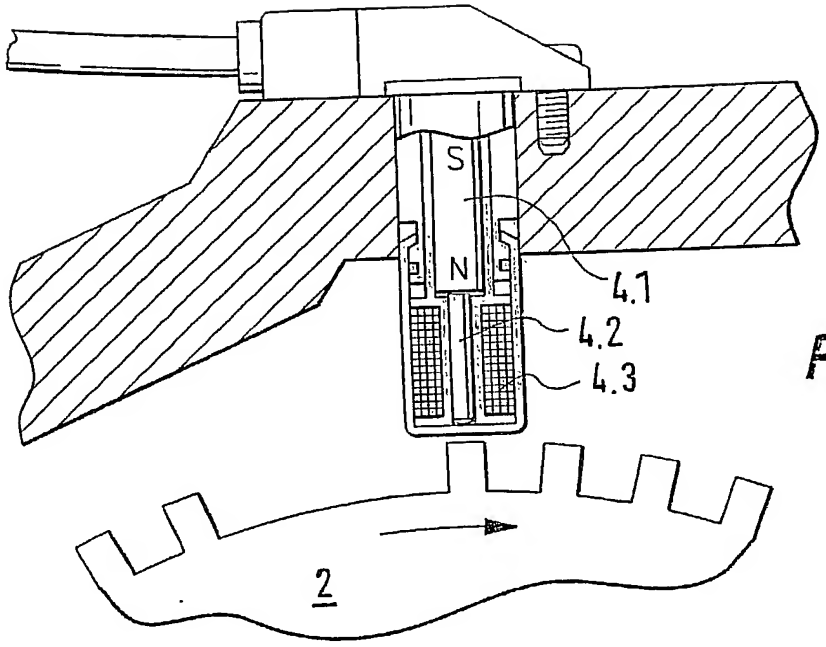


Fig. 2a

Fig. 2b

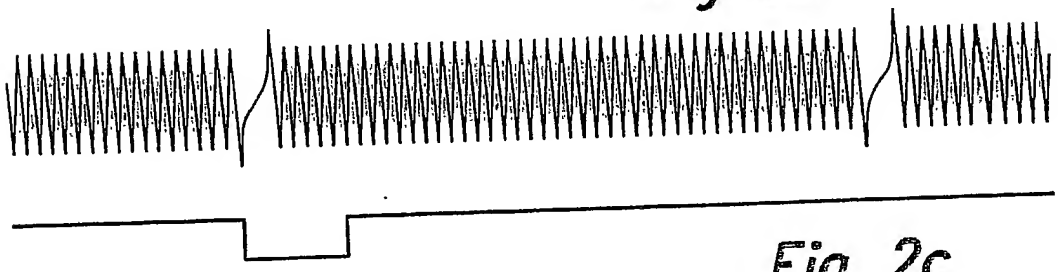


Fig. 2c

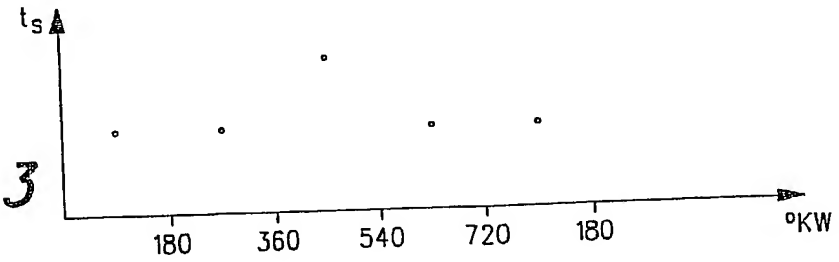


Fig. 3

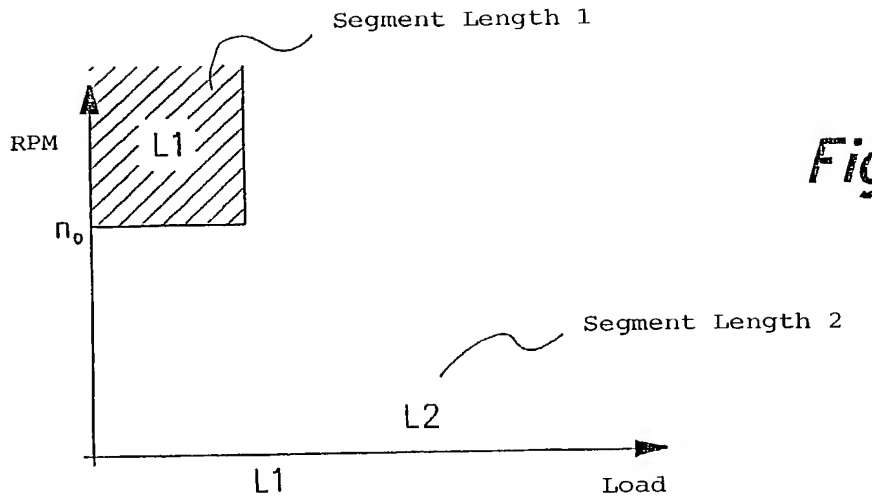


Fig. 4a

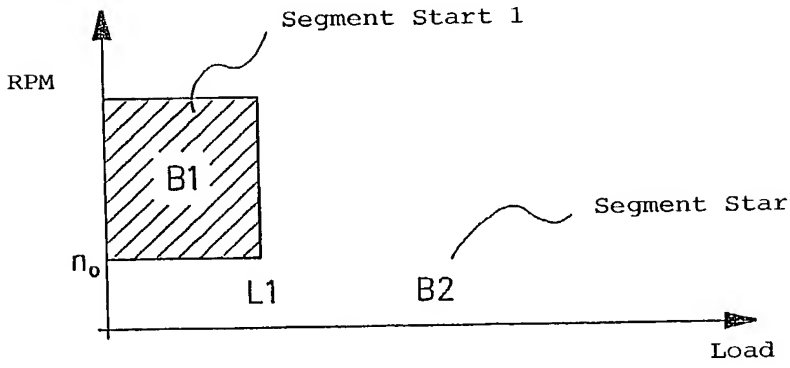


Fig. 4b

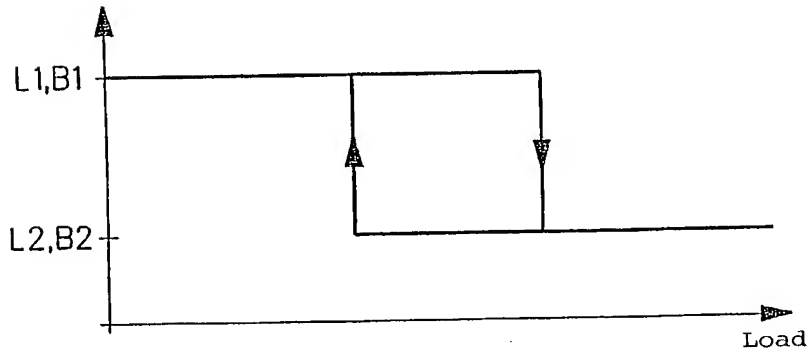


Fig. 4c

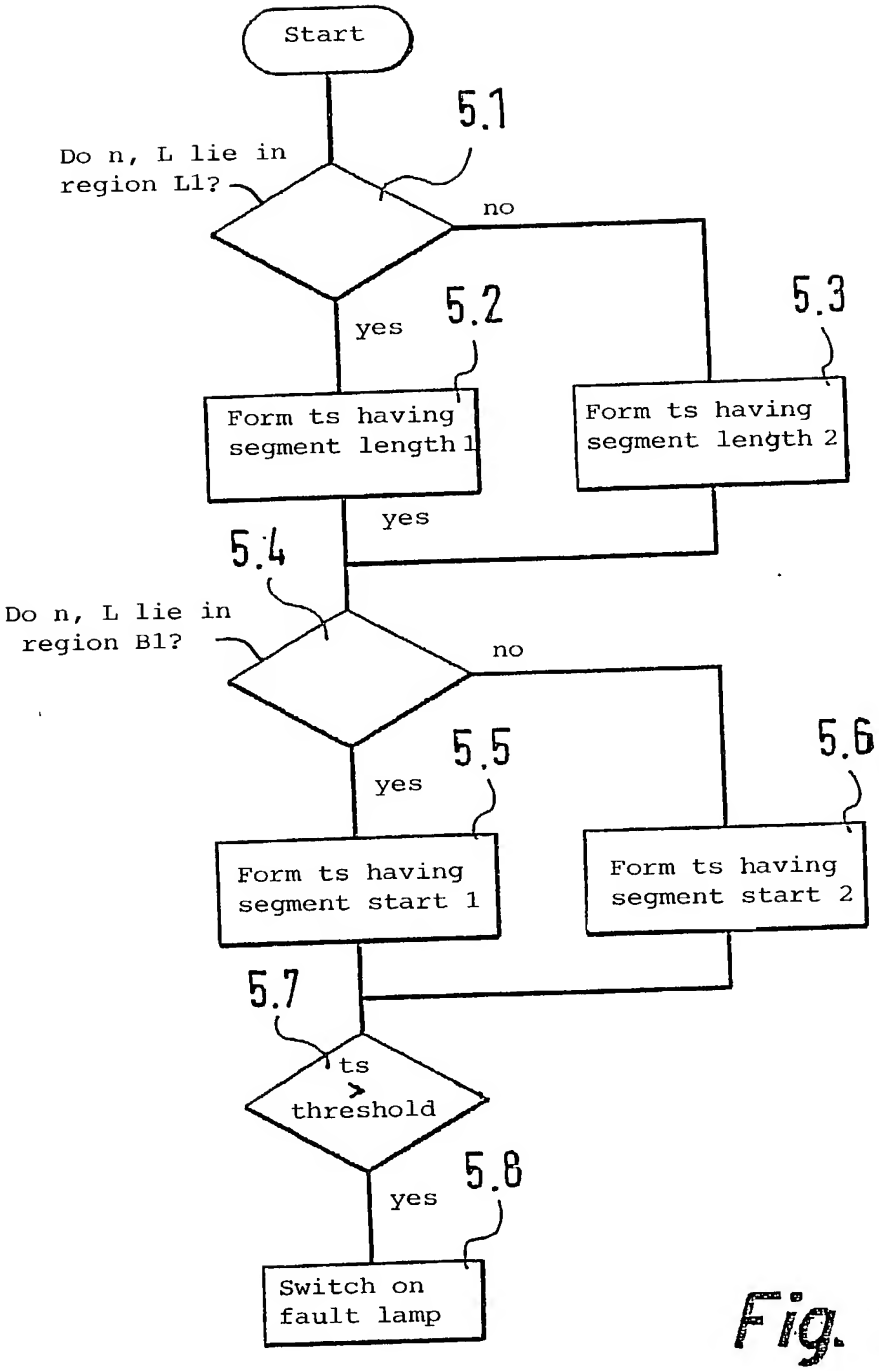

Start
5.1
Do n, L lie in region L1?
no
yes
5.2
5.3
Form ts having segment length 1
Form ts having segment length 2
yes
5.4
Do n, L lie in region B1?
no
yes
5.5
5.6
Form ts having segment start 1
Form ts having segment start 2
5.7
ts > threshold
yes
5.8
Switch on fault lamp

Fig. 5

Attorney Docket No. R 37032

Declaration and Power of Attorney for National Stage of PCT Patent Application

As a below named inventor, I hereby declare that:

My residence, post office address and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled: Combustion Misfire Detection, the specification of which was filed as PCT International Application number PCT/DE 00/03024 on September 2, 2000.

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a).

I hereby claim foreign priority benefits under Title 35, United States Code, §119, of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed	
199 46 873.7 (Number)	Federal Republic of Germany (Country)	30 Sep 99 Date Filed	X Yes	___ No

As a named inventor, I hereby appoint the following attorney to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith:

Walter Ottesen
Reg. No. 25,544 (1)

Direct all telephone calls to Walter Ottesen at telephone no. (301) 869-8950 and address all correspondence to:

Walter Ottesen
Patent Attorney
P.O. Box 4026
Gaithersburg, Maryland 20885-4026

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of sole or first inventor, if any Michael Lehner

Inventor's signature Michael Lehner Date 15 Dez. 2001

Residence 75417 Muehlacker, Federal Republic of Germany

Country of Citizenship Federal Republic of Germany

Post Office Address Vaihinger Strasse 16, 75417 Muehlacker
Federal Republic of Germany

Full name of second joint inventor, if any 2) Andrea Lohmann

Inventor's signature Andrea Lohmann Date 20.12.2001

Residence 70195 Stuttgart, Federal Republic of Germany DE

Country of Citizenship Federal Republic of Germany

Post Office Address Himmerreichstrasse 37, 70195 Stuttgart
Federal Republic of Germany